DIAPHRAGM

Lecture (3)

Last updated: March 2013

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Objectives:

- **Basic anatomy, to identify:**
  - Shape and attachments of the diaphragm.
  - Nerves and blood vessels that supply the diaphragm.
  - Functions of the diaphragm.
- **Clinical anatomy, to define:**
  - Hernias.types of diaphragmatic hernias.
- **Radiology, to identify:**
  - Diaphragm in noraml chest x-Ray

Introduction: Lecture's map

- Description.
- Openings of the diaphragm.
- Blood supply and innervation.
- Function and movements of the thoracic wall during respiration.
- Hernias:
  - Acquired: diaphragmatic hiatal hernias
  - Congenital diaphragmatic hernia.

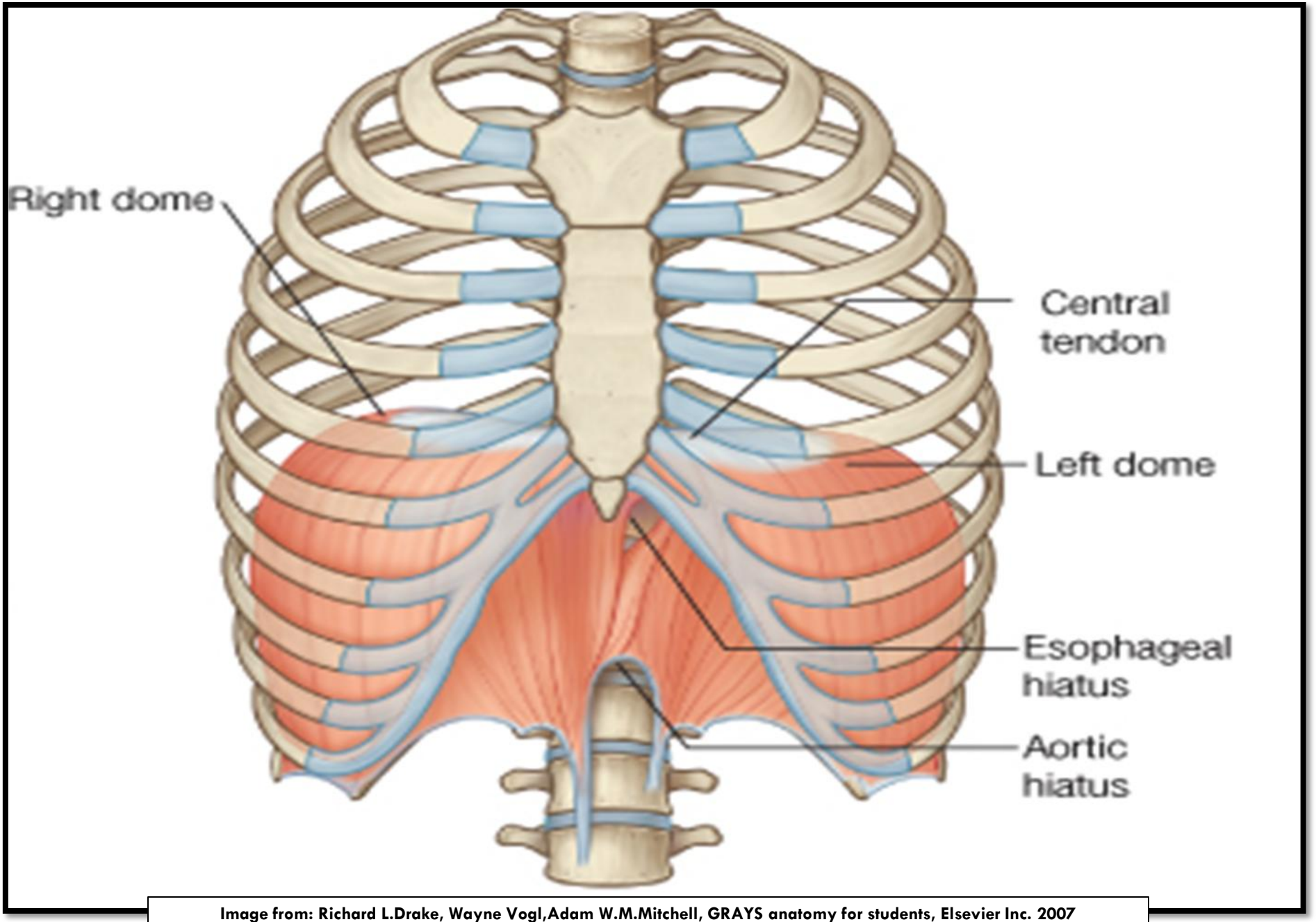
Diaphragm

- It is a musculotendinous partition separating the thoracic and abdominal cavities.

The diaphragm
is shaped
like a parachute

Description (1)

- Its convex superior surface faces the thoracic cavity.
- Its concave inferior surface faces the abdominal cavity.



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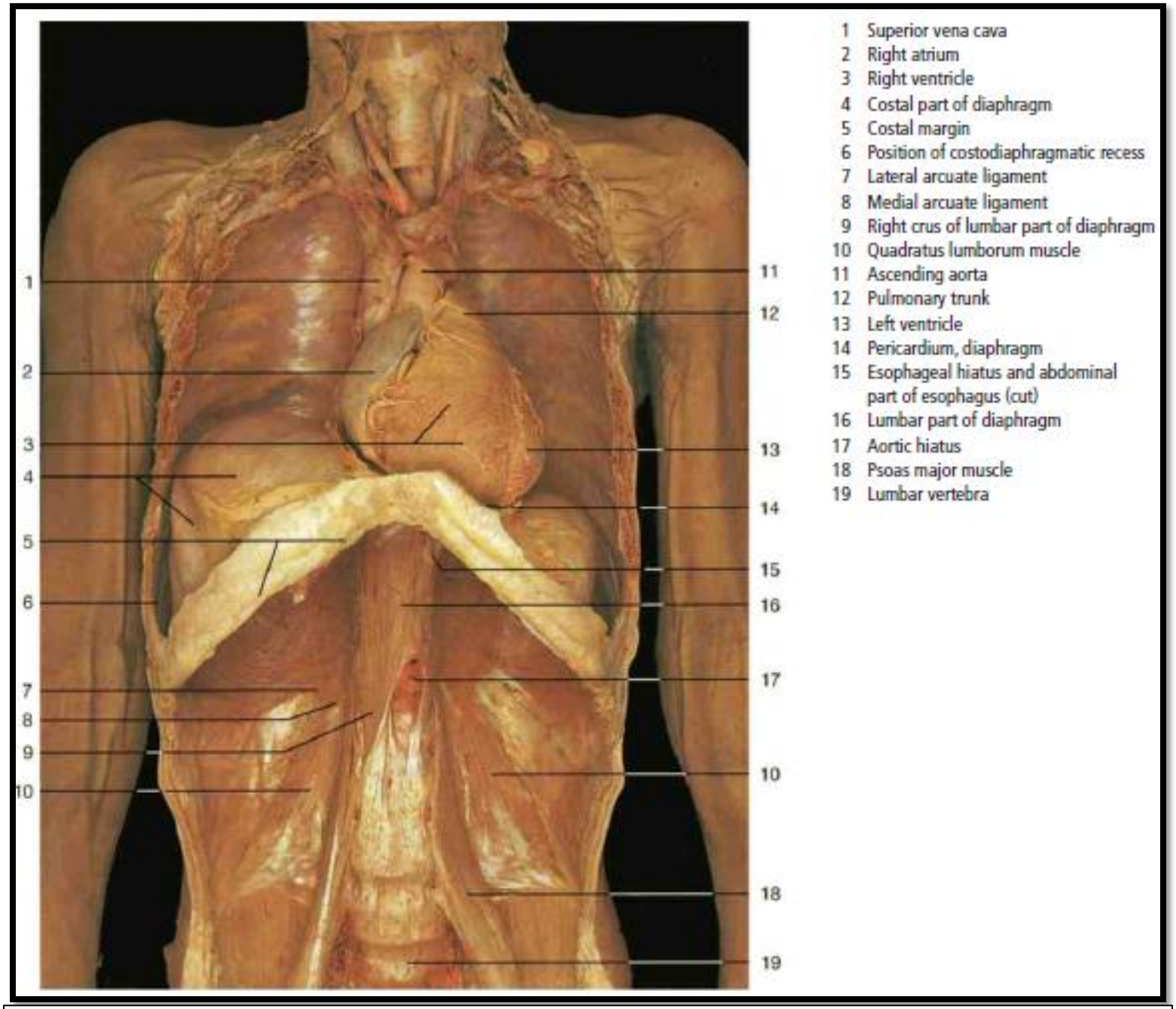
Description (2)

- It curves superiorly into right and left domes.
- The right dome is higher than the left owing to the presence of the liver.



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During expiration

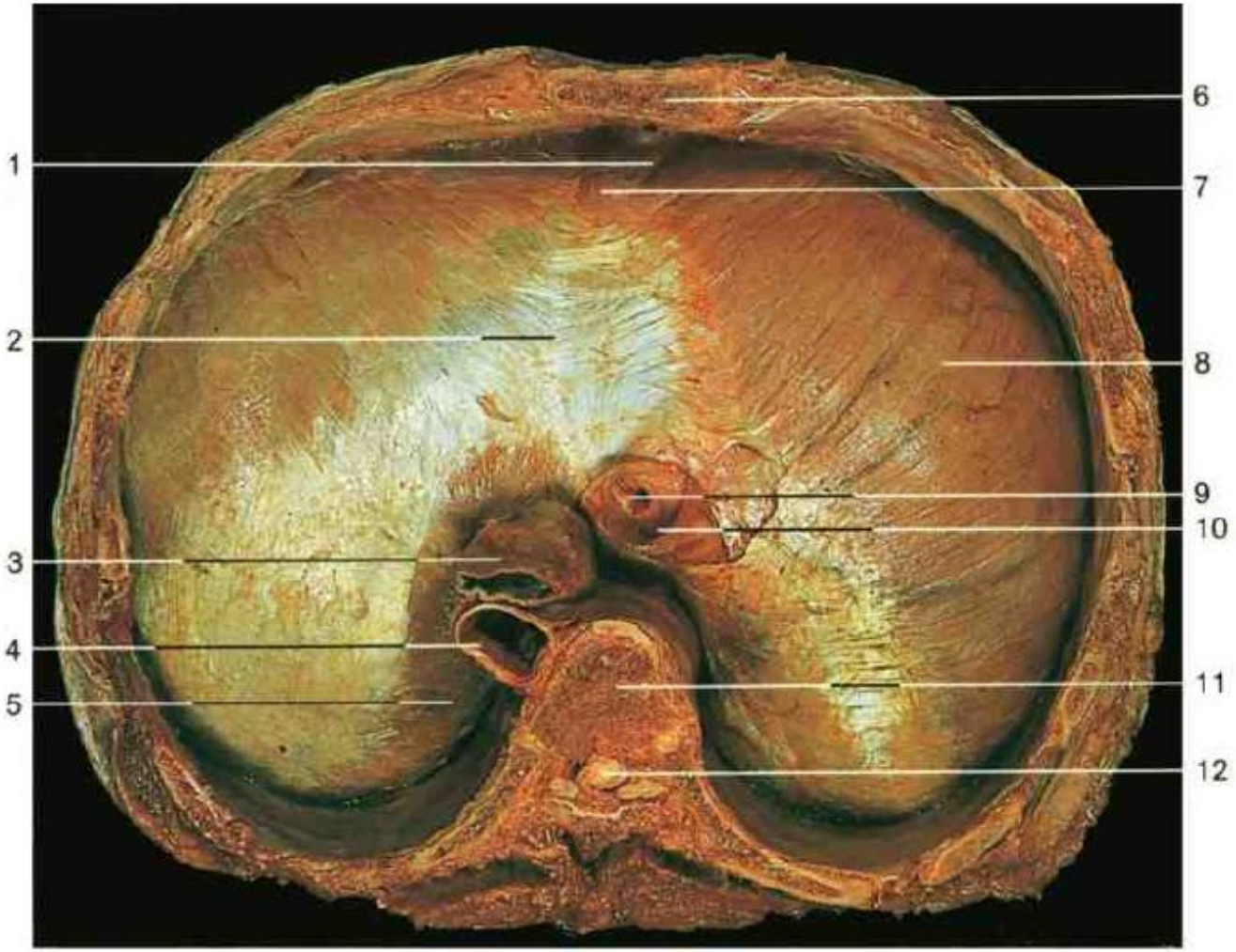
- The right dome ascends to the 5th rib.
- The left dome ascends to the 5th intercostal space.

- **The level of the domes of the diaphragm varies according to the:**
  - **Phase of respiration (inspiration or expiration).**
  - **Posture (e.g., supine or standing).**
  - **Size and degree of distension of the abdominal viscera.**

Parts of the diaphragm

- Central tendon.
- Muscular part:
  - Sternal part.
  - Costal part.
  - Lumbar part.

Superior view



1 Sternocostal triangle
2 Central tendon (from above)
3 Esophagus
4 Aorta
5 Lumbar part of diaphragm
6 Sternum
7 Sternal part of diaphragm
8 Costal part of diaphragm
9 Entrance of hepatic veins
10 Inferior vena cava
11 Body of 9th thoracic vertebra
12 Spinal cord

Diaphragm (superior aspect). The pleura and pericardium have been removed.

Image from: Johannes W.Rohen; Chihiro Yokochi; Elke Lütjen-Drecoll. Color atlas of anatomy. 7th edition. Lippincott Williams & Wilkins

Muscular Parts of the diaphragm: 1. Sternal part

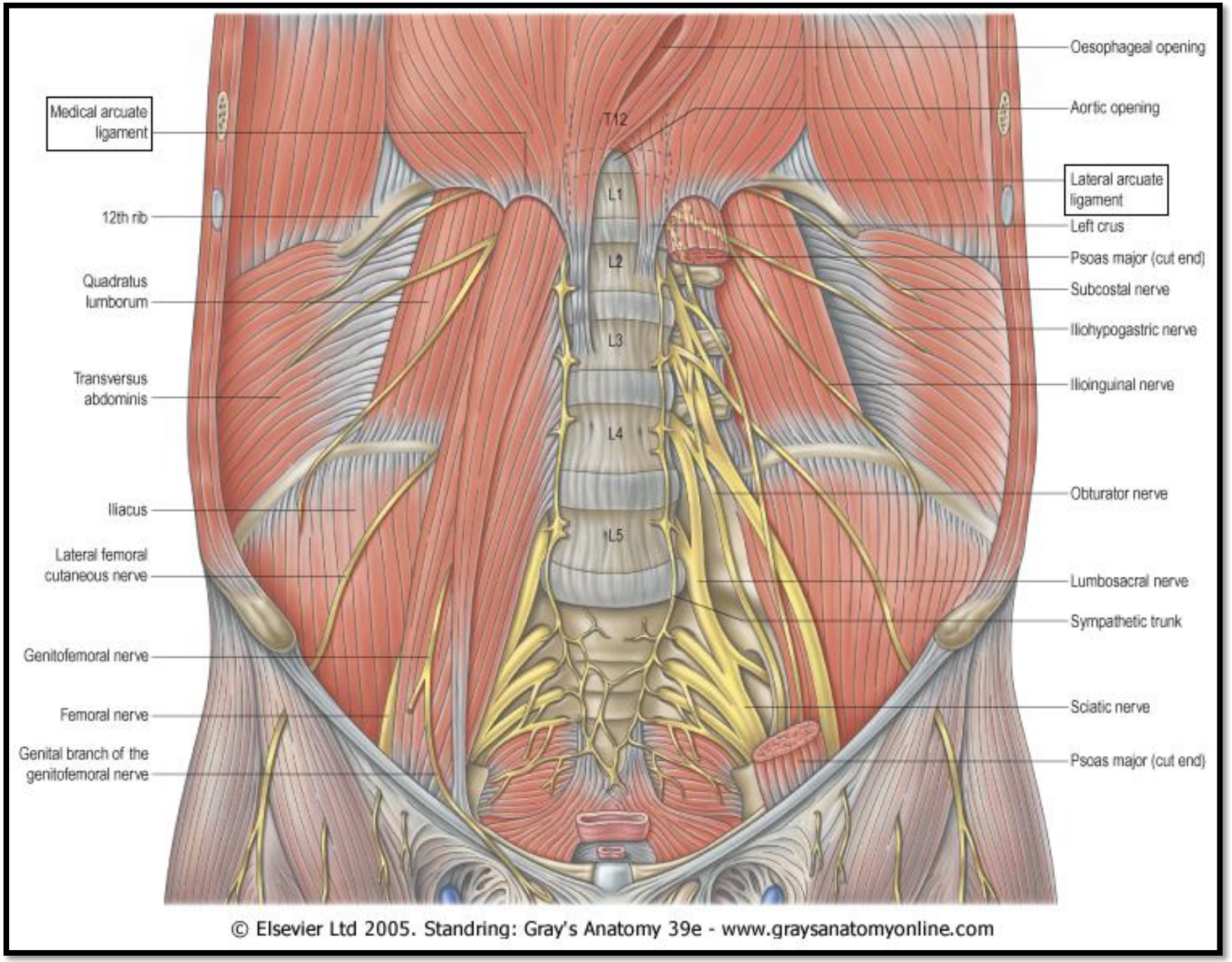
- Consists of two muscular slips that attach to the posterior aspect of the xiphoid.

Muscular Parts of the diaphragm: 2. Costal part

- Consists of wide muscular slips that attach to the internal surfaces of the inferior six costal cartilages and their adjoining ribs on each side.

Muscular Parts of the diaphragm: 3. Lumbar part

- **Arises from:**
  - **The medial and lateral arcuate ligaments.**
  - **The right and left crura (singular: crus).**


Medical arcuate ligament
12th rib
Quadratus lumborum
Transversus abdominis
Iliacus
Lateral femoral cutaneous nerve
Genitofemoral nerve
Femoral nerve
Genital branch of the genitofemoral nerve
T12
L1
L2
L3
L4
L5
Oesophageal opening
Aortic opening
Lateral arcuate ligament
Left crus
Psoas major (cut end)
Subcostal nerve
Iliohypogastric nerve
Ilioinguinal nerve
Obturator nerve
Lumbosacral nerve
Sympathetic trunk
Sciatic nerve
Psoas major (cut end)
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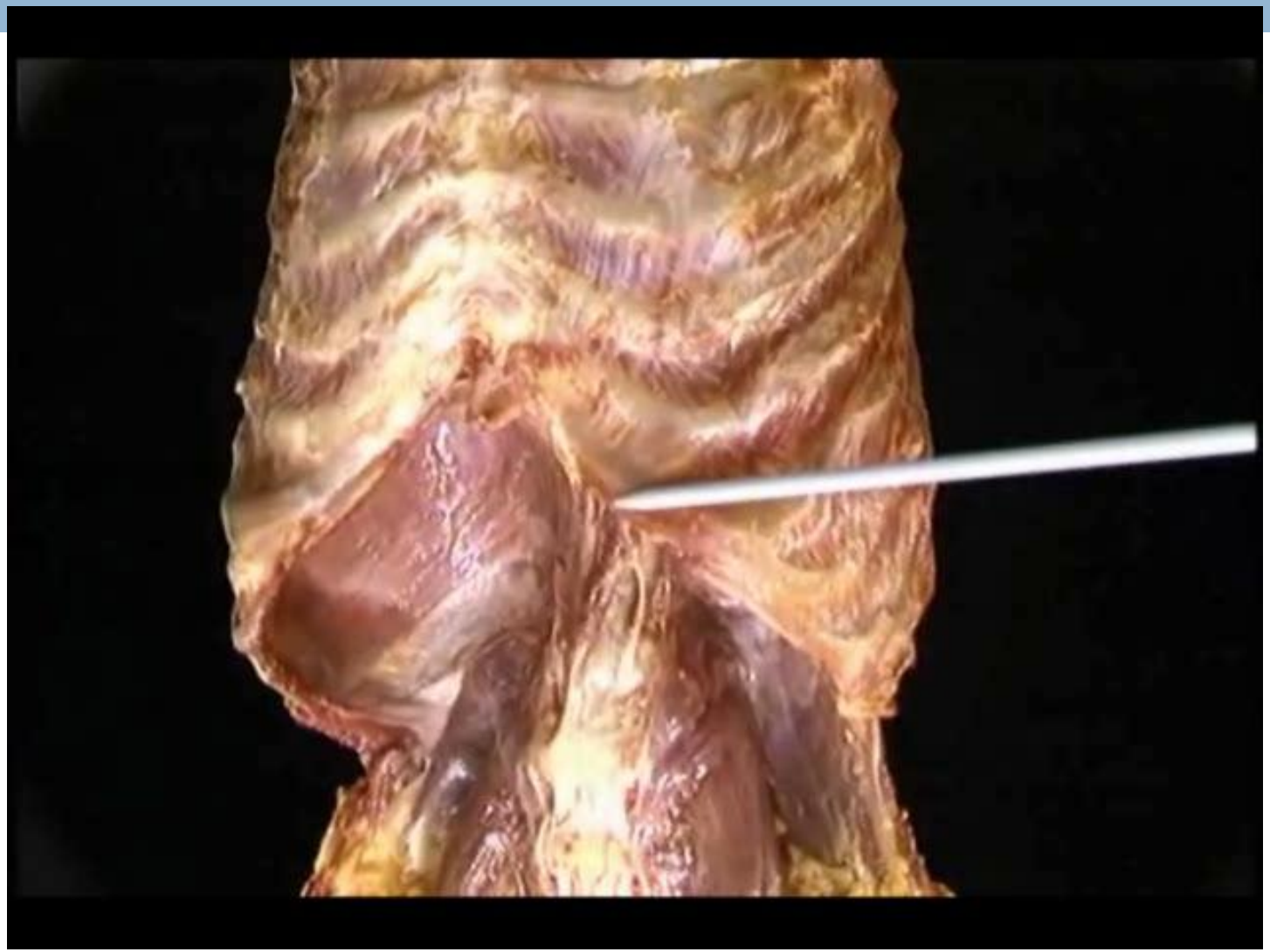
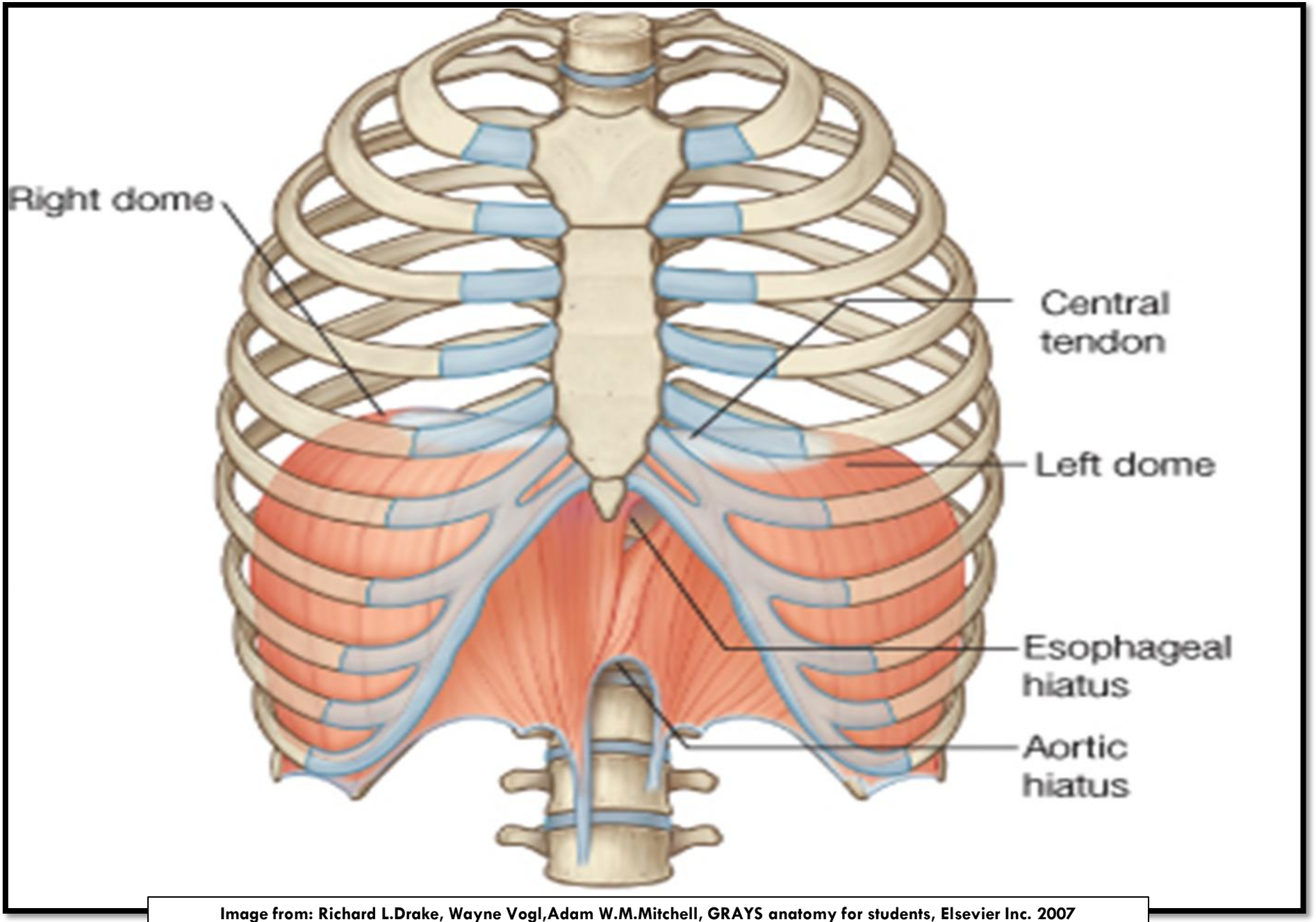
Line of attachment of the diaphragm (Video)

Video from: Acland's video Atlas of Human Anatomy, Robert D.Acland M.D , FRCS



The crura of the diaphragm

- Are musculotendinous bundles.
- **The right crus:**
  - Larger and longer, arises from the first three or four lumbar vertebrae.
- **The left crus:**
  - Arises from the first two or three.



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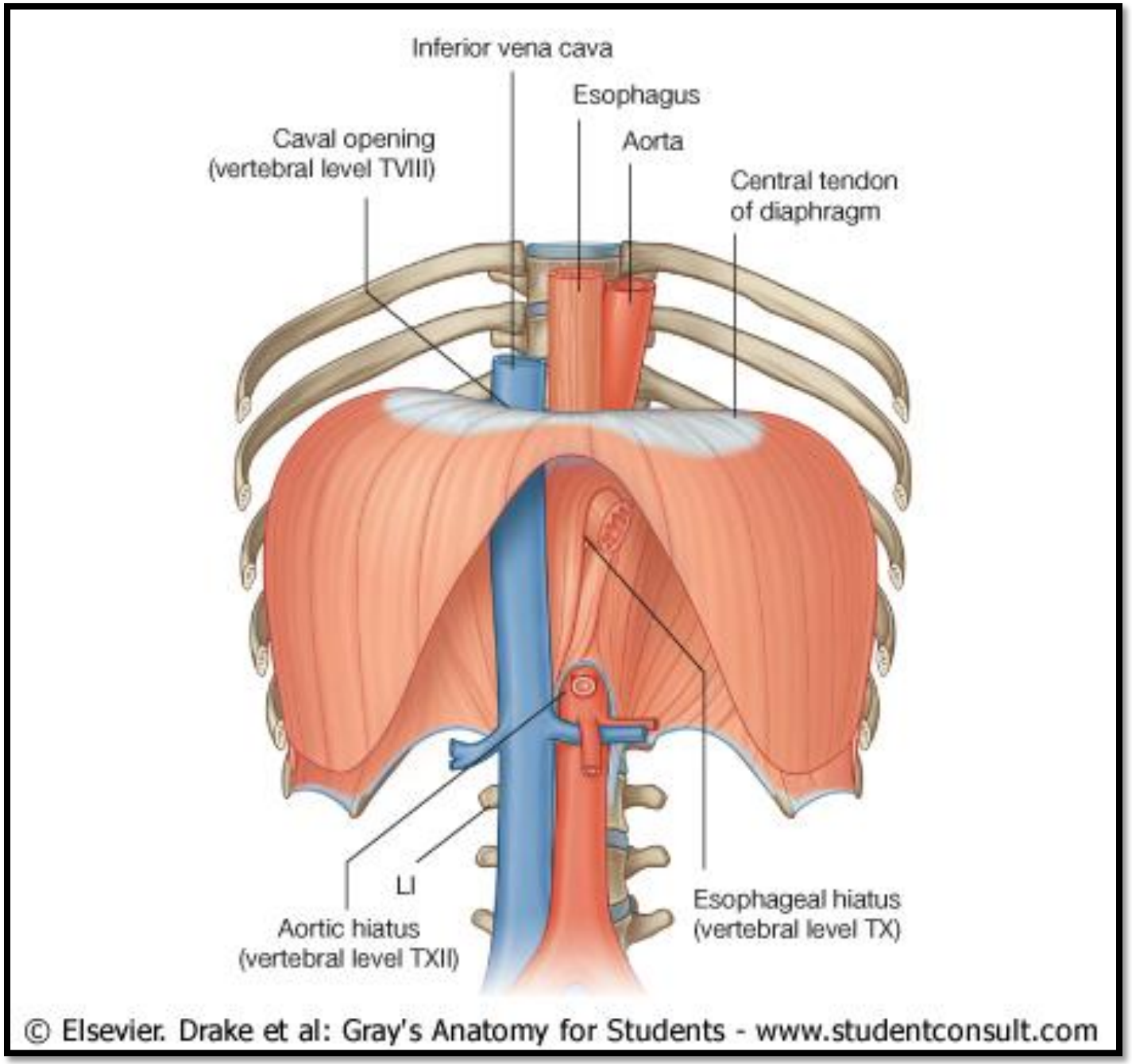
Lecture's map

- Description.
- **Openings of the diaphragm.**
- **Blood supply and innervation.**
- **Function and movements of the thoracic wall during respiration.**
- **Hernias:**
  - **Acquired: diaphragmatic hiatal hernias**
  - **Congenital diaphragmatic hernia.**

Main openings of the diaphragm

- Caval Opening.
- Esophageal opening.
- Aortic opening.


Inferior vena cava
Esophagus
Caval opening
(vertebral level TVIII)
Aorta
Central tendon
of diaphragm
LI
Aortic hiatus
(vertebral level TXII)
Esophageal hiatus
(vertebral level TX)
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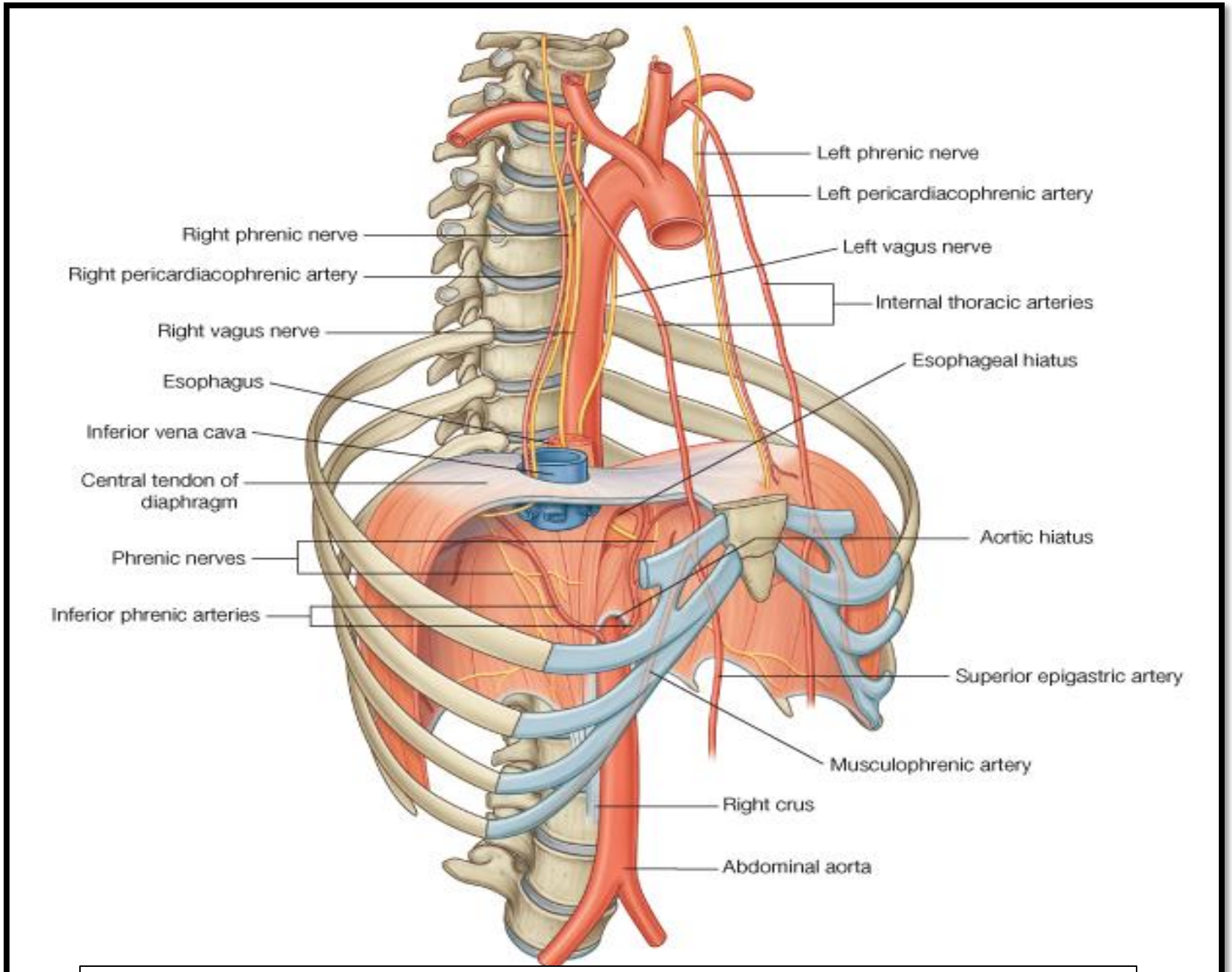
Caval Opening

- **Location: the central tendon.**
- **Level :T8 vertebra.**
- **Transmits:**
  - **The IVC.**
  - **Branches of the right phrenic nerve.**
  - **A few lymphatic vessels.**



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Esophageal Hiatus

- **Location** : right crus (muscular part)
- **Level** :T10 vertebra.
- **Transmits** :
  - The esophagus.
  - Anterior and posterior vagal trunks.
  - Esophageal branches of the left gastric vessels,
  - A few lymphatic vessels.

Aortic Hiatus

- **Location : posterior to the diaphragm**
- **Level : T12 vertebra.**
- **Transmits:**
  - **The aorta.**
  - **The thoracic duct.**
  - **The azygos vein.**

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Blood supply of the diaphragm

Superior Surface of Diaphragm	Inferior Surface of Diaphragm
Superior phrenic, Musculophrenic and pericardiophrenic arteries and veins	Inferior phrenic arteries and veins

Innervation of the diaphragm

Innervation	Centrally	Peripherally
Motor supply	Phrenic nerves (C3, C4 and C5)	
Sensory supply	Phrenic nerves (C3, C4 and C5)	Intercostal nerves

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Function

The diaphragm is the chief muscle of inspiration.

Movements of the Thoracic Wall and the Diaphragm

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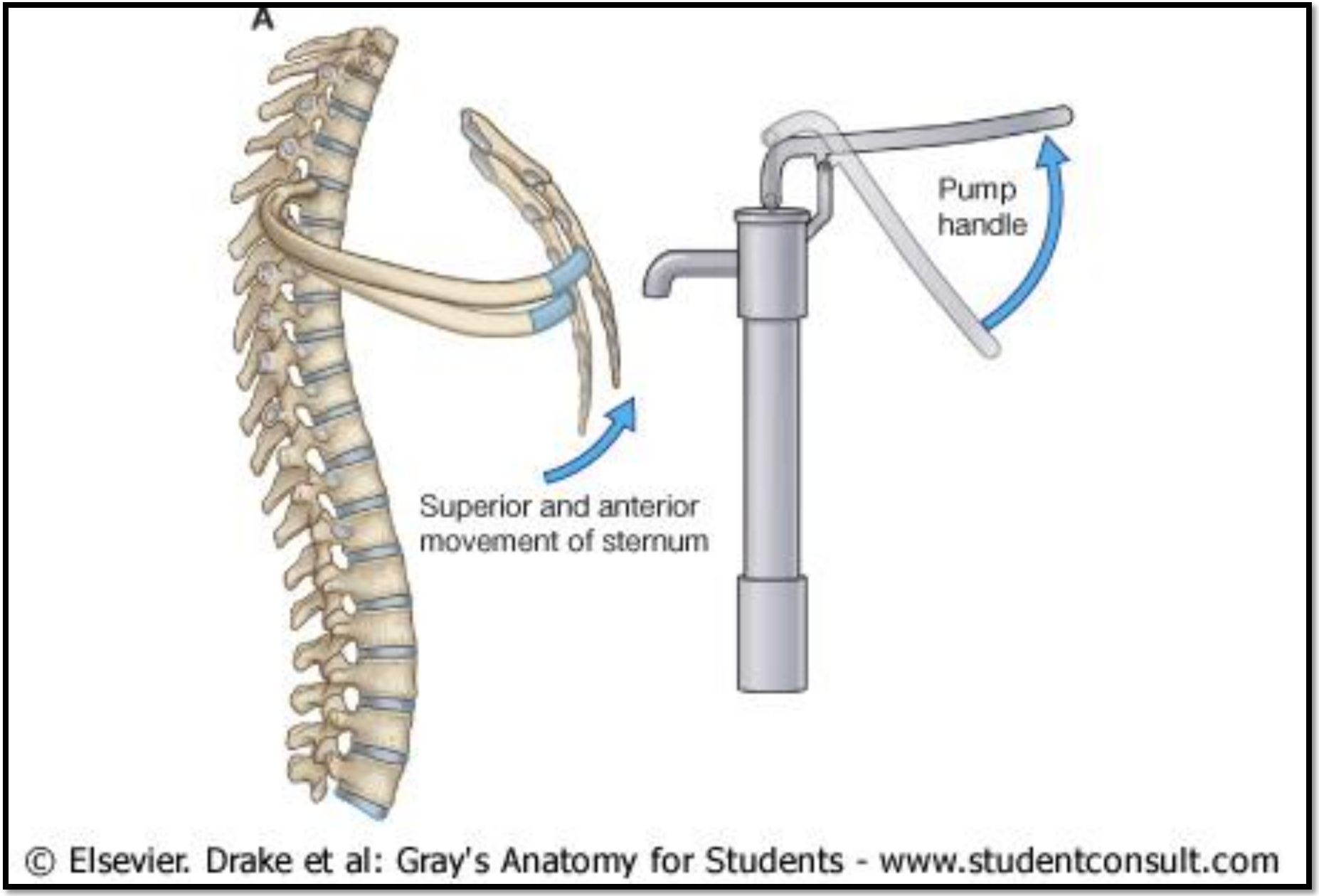
A
Pump handle
Superior and anterior movement of sternum
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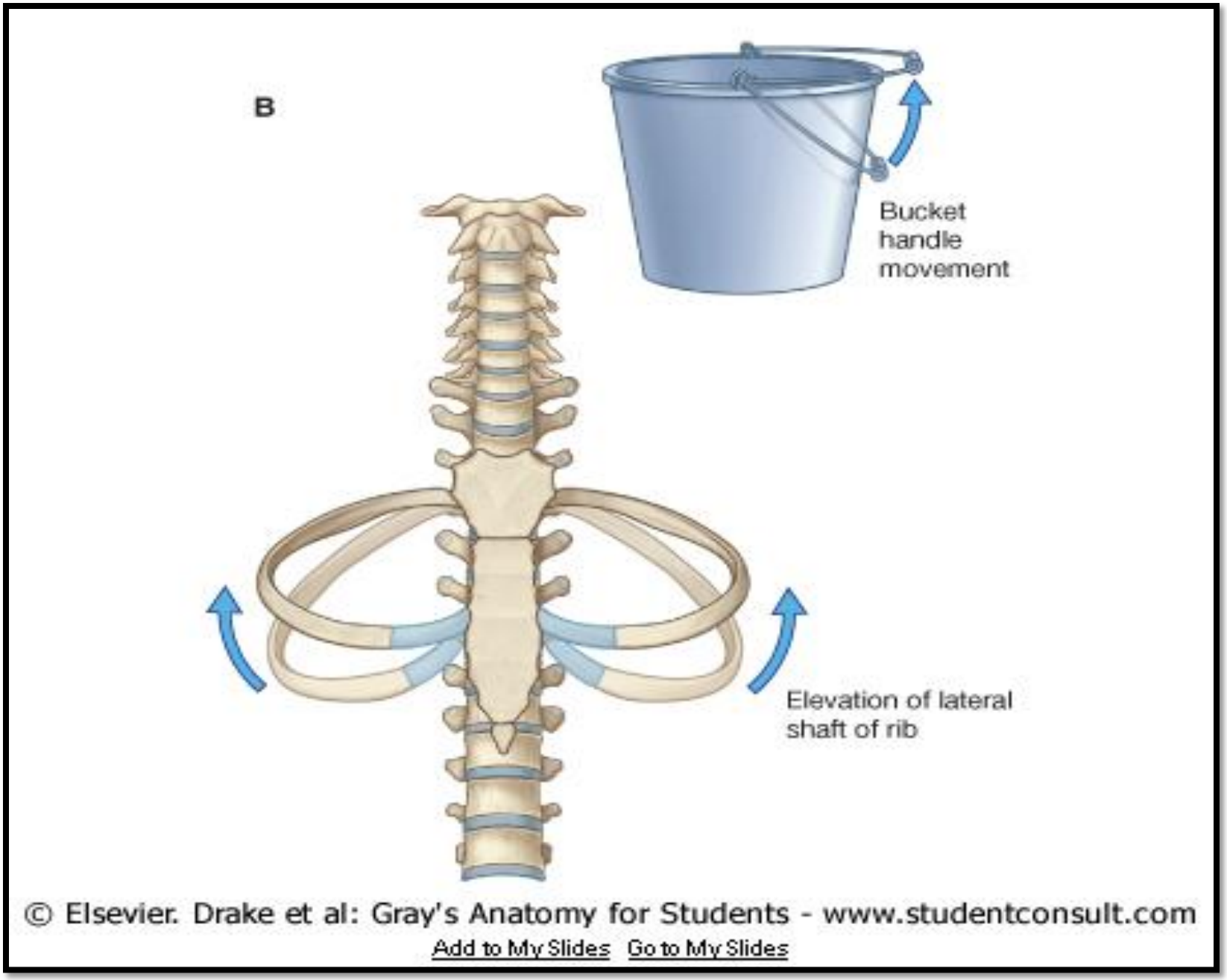
B
Bucket handle movement
Elevation of lateral shaft of rib
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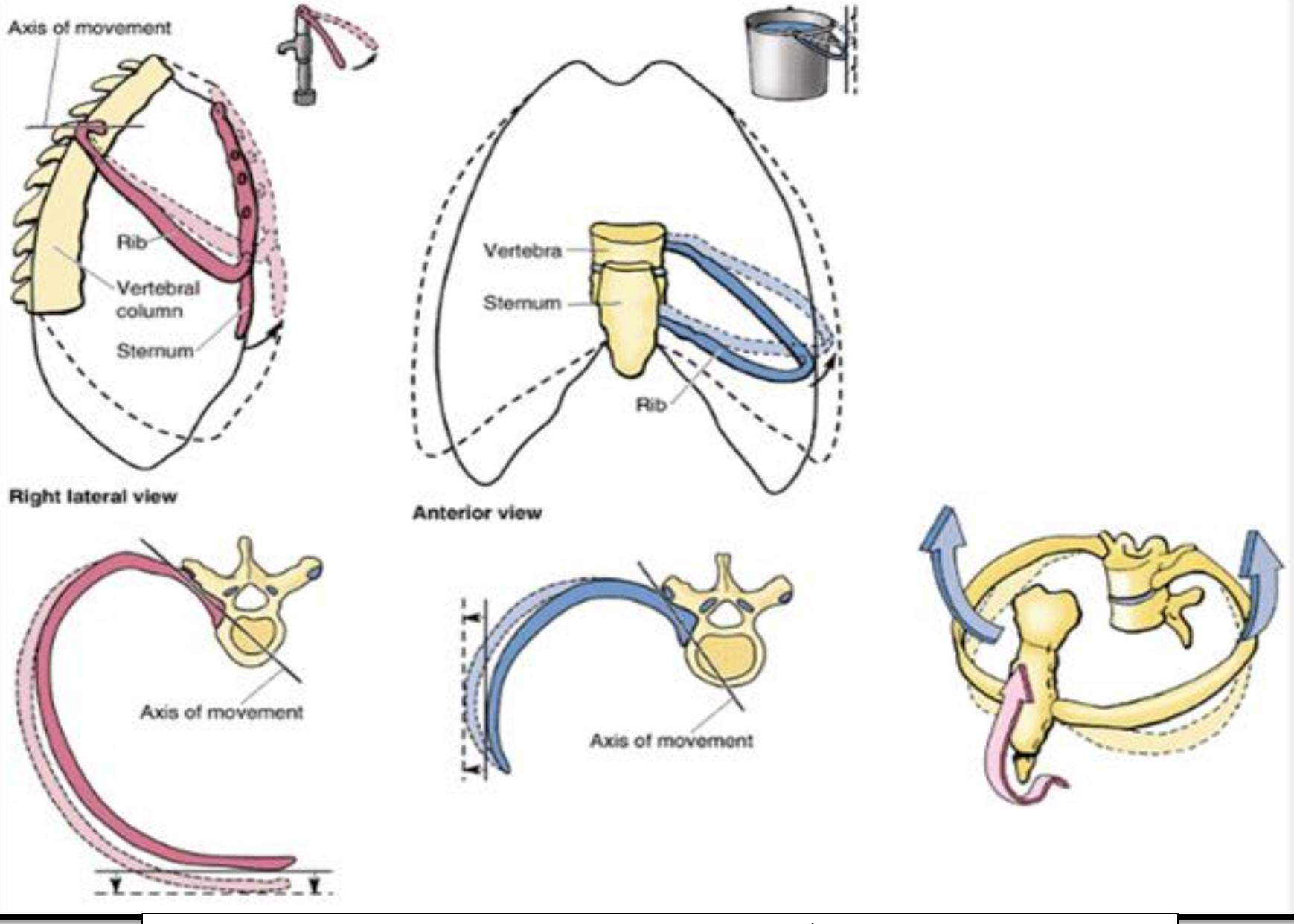

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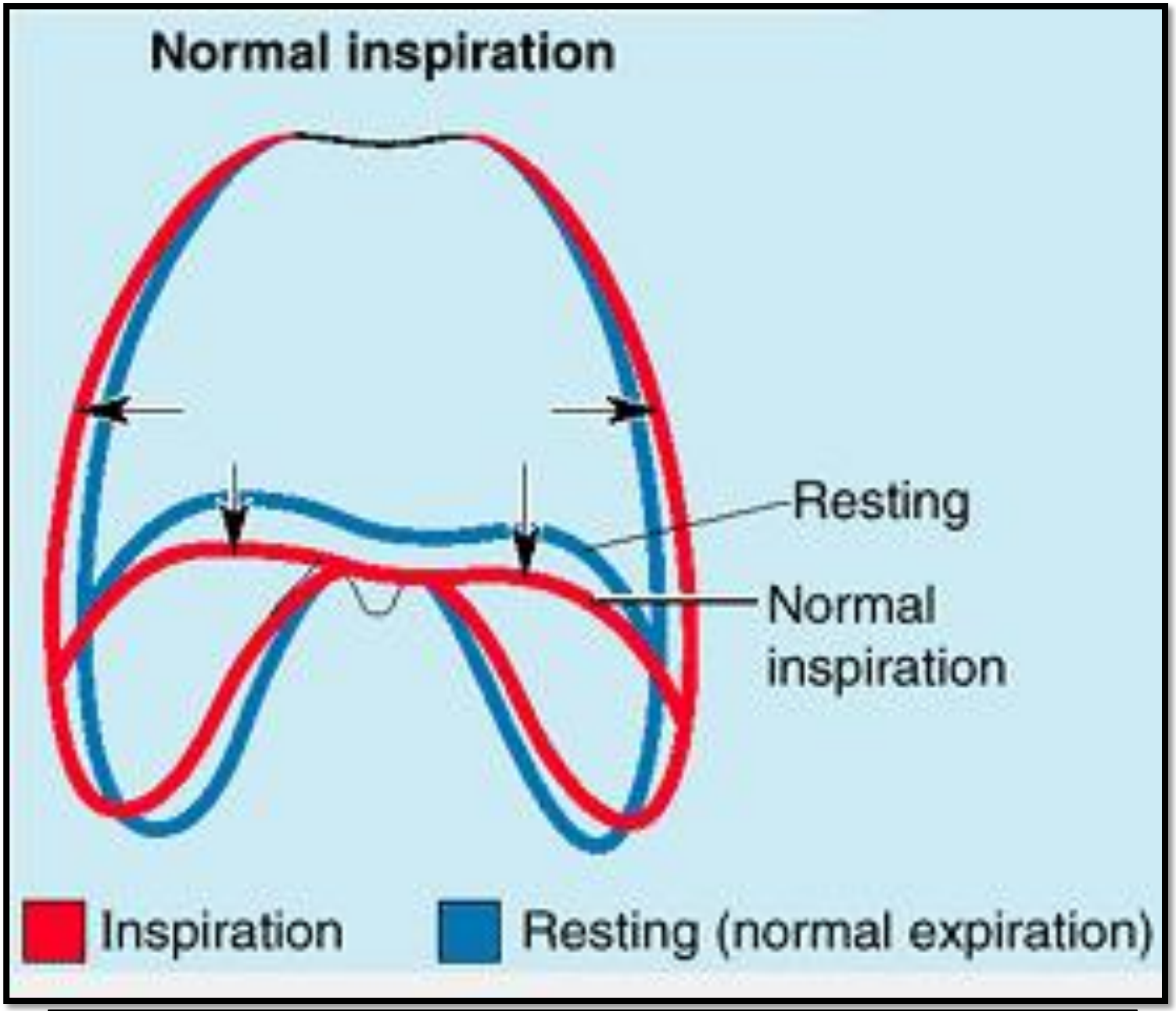

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Clinical note: Hernia

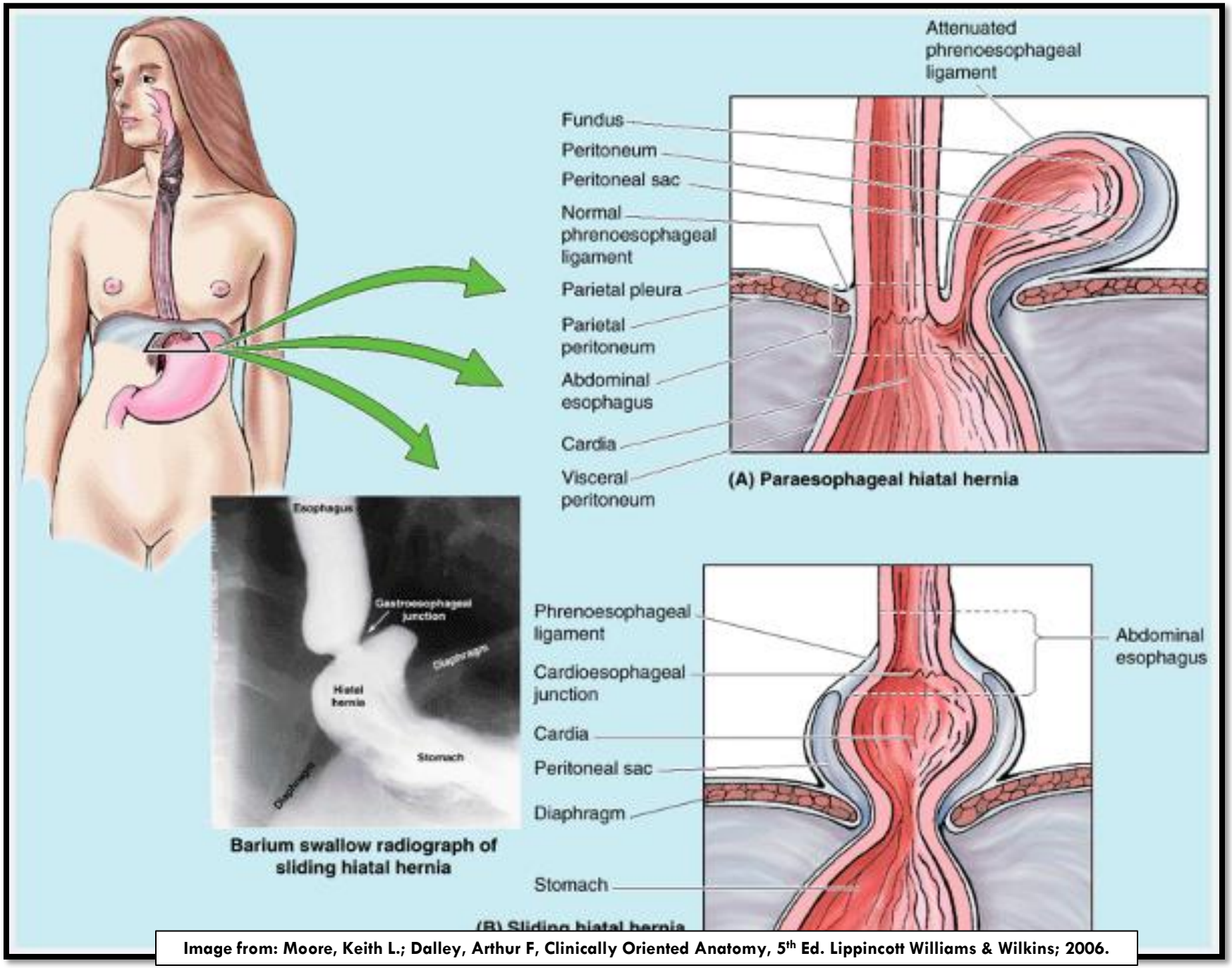
- It is protrusion of viscus or part of it through an abnormal opening (or weakness) in the wall of its containing cavity.

Clinical note: Diaphragmatic Hernias

1. **Acquired: Hiatal Hernia.**
2. **Congenital Diaphragmatic Hernia.**

Clinical note: Hiatal Hernia

- It is a protrusion of a part of the stomach into the mediastinum through the esophageal hiatus of the diaphragm.
- Two main types:
  - Paraesophageal hiatal hernia.
  - Sliding hiatal hernia.



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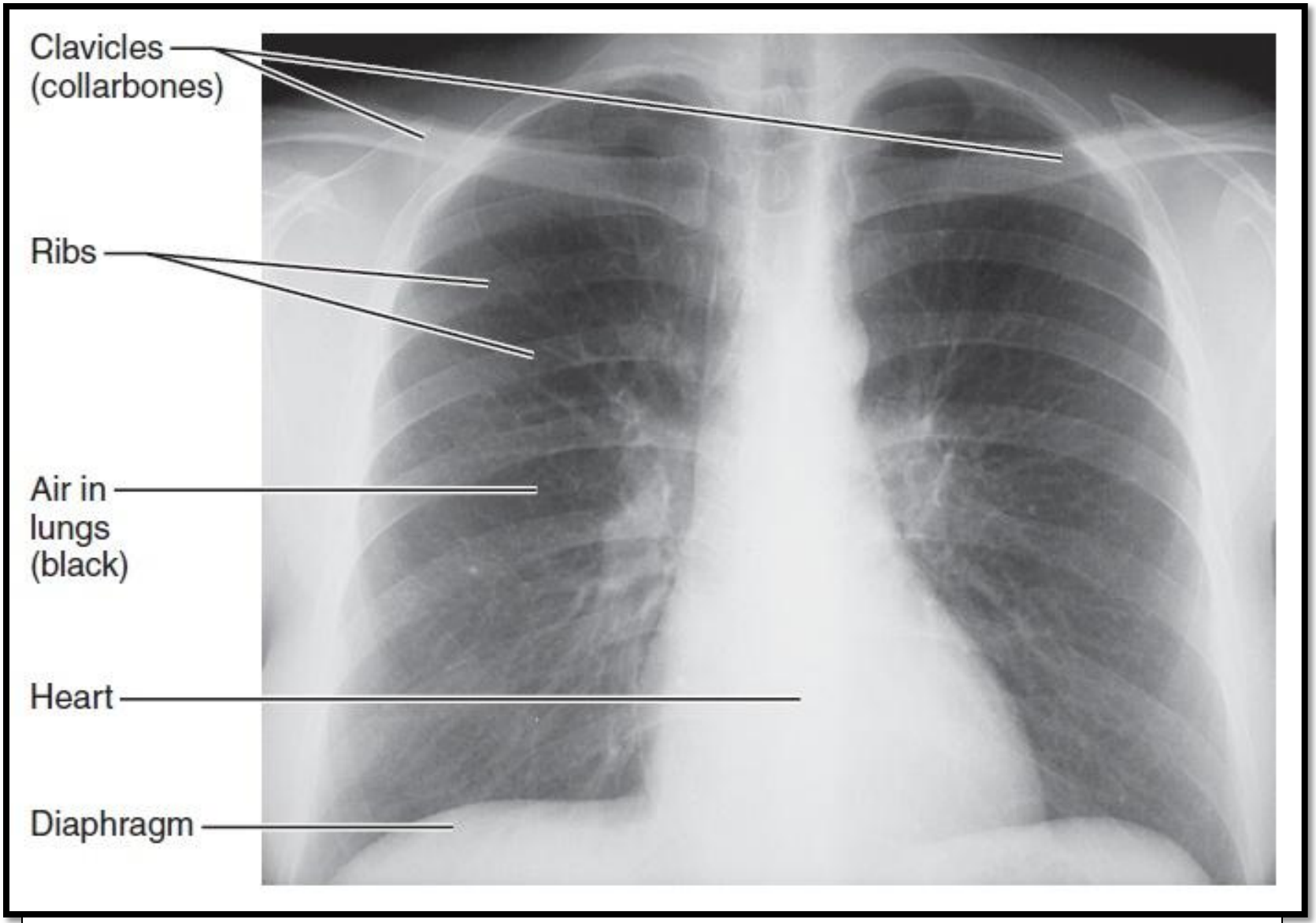
Congenital Diaphragmatic Hernia

- Part of the stomach and intestine herniate through a large posterolateral defect in the diaphragm.

Clinical note: Hiccups

- Hiccups are involuntary, spasmodic contractions of the diaphragm, causing sudden inhalations that are rapidly interrupted by spasmodic closure of the glottis.
- Hiccups result from irritation of the phrenic nerves.

Radiology: Normal chest X-Ray



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Please try to answer this question

- During inspiration:
  - A. Ribs move downwards.
  - B. Diaphragm contracts.
  - C. Sternum moves backwards.
  - D. Intra-bdominal pressure decrease.
  - E. Intra-thoracic cavity narrows.

Please try to answer this question

- **The sensory innervation of the peripheral part of the diaphragm is achieved by:**
  - A. **Vagus nerve.**
  - B. **Phrenic nerve.**
  - C. **C3, C4 and C5.**
  - D. **Intercostal nerves.**
  - E. **Recurrent laryngeal nerve**

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